THE RESISTANCE SCREENING CENTER

Screening for Fusiform Rust Resistance as a Service for Tree Improvement Programs

U.S. Department of Agriculture Forest Service
Southeastern Area, State and Private Forestry

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Services Of The Resistance Screening Center

WHO USES THE CENTER — AND WHY

The Resistance Screening Center evaluates pine seedlings for resistance to fusiform rust[1] as a service to tree improvement specialists, seed orchard managers, scientists, and others in government agencies, research institutions, and private industry. The test enables clients to obtain information on the resistance of their pines in much less time than is possible in field progeny tests. The Center provides information on loblolly pine resistance in 13 months, and slash pine resistance in 8 months, whereas field progeny tests require 4 or 5 years. By using information from these tests, trees producing rust-resistant progeny are identified.

WHO OPERATES THE CENTER — AND HOW

The Center is operated by the Forest Pest Management Staff of the Forest Service's Southeastern Area, State and Private Forestry. The Center is located at the Bent Creek Experimental Forest near Asheville, N.C.

The Center employs the controlled basidiospore suspension (CBS) system developed by the Forest Service's Southeastern Forest Experiment Station. Pine seedlings are uniformly inoculated using a carefully controlled inoculum density and a mechanized spray inoculation system.

THE THREAT OF FUSIFORM RUST

The Resistance Screening Center was established in 1973 to meet the threat to southern forests from fusiform rust. This fungus-caused disease is considered the most destructive forest disease in the South. The fungus is widely distributed from eastern Maryland to Florida and west to Texas and southern Arkansas. The severity of the disease varies geographically. In some high-hazard areas it is impossible to grow susceptible trees to harvestable size. Annual losses attributed to the rust are estimated, in a 1979 case history report, at 600 million cubic feet of southern pine timber, both by degrade and mortality. Using a 1970 blended price of $0.1836 per cubic foot, this would amount to a loss of slightly over $110 million in stumpage per year.

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[1] Fusiform rust is caused by *Cronartium quercuum* (Berk.) Miyabe ex Shirai f. sp. *fusiforme* (Cumm.) Burds. et Snow.

STRATEGY: INCREASE GENETIC RESISTANCE

Although the disease can be controlled in pine nurseries by fungicides, the use of chemicals to prevent or control the rust in natural or planted stands is not economical. Fortunately, some pines have a natural resistance to fusiform rust. This genetically controlled resistance offers a method to reduce or minimize rust losses. Researchers have identified loblolly and slash pine families that have a high proportion of trees with much more resistance to rust than is found among pines in general. Resistance screening serves to test pine progeny as fast as possible to accelerate the process of identifying resistant parents.

RESISTANCE SCREENING PROCESS

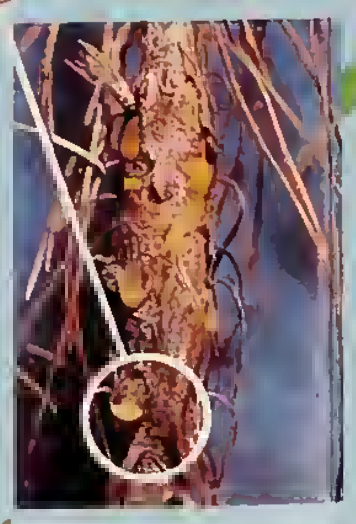
The screening process is coordinated with the life cycle of the fungus. For a detailed life cycle, unfold the leaflet completely and look at the reverse side. The life cycle involves two hosts. The aeciospores produced on pines infect only oaks. Basidiospores of the fungus are produced on oaks, and infect only pines. Biological materials from both hosts are kept on hand at the Center at all times so that testing can be done year-round. Aeciospores from the fusiform rust fungus are collected and processed for long-term storage each spring. Spores are collected from both loblolly and slash pines in 30 collection areas across the South. In addition, acorns of northern red oak are collected and stored each fall.

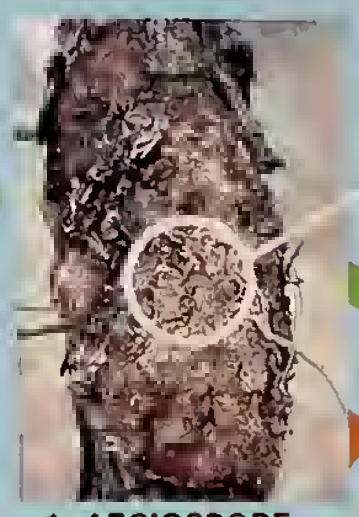
The primary steps in the screening process are:

1. Germinate and grow pine seedlings from different seed sources. A seed source may represent an open pollinated family, controlled cross, bulk collection, etc.

FUSIFORM RUST

PYCNIA

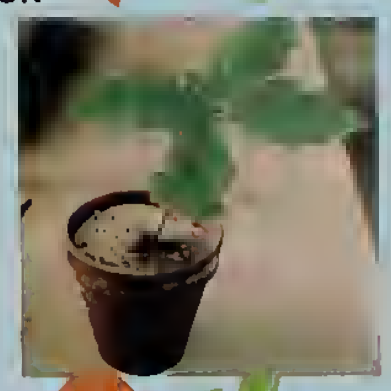




1. AECIOSPORE COLLECTION

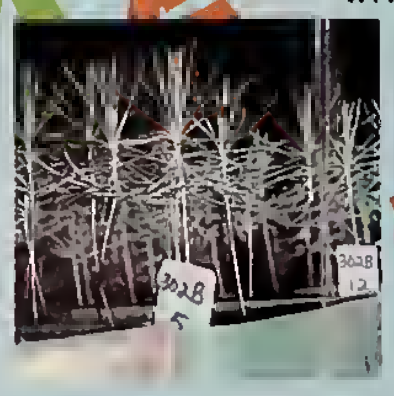
AECIA

2. OAK INOCULATION



3. TELIA PRODUCTION

4. PINE INOCULATION WITH BASIDIOSPORES



5. INFECTION EVALUATION

THE SCREENING PROCESS

The screening process parallels the life cycle of the fusiform rust fungus. (1) Aeciospores are collected from the forest each spring. (2) When a resistance screening test is initiated, tender oak leaves are inoculated with aeciospores. Urediospore production is by-passed in the screening process, but, (3) telia form on the underside of the oak leaves. Basidiospores are induced to form on the telia in the laboratory and they are used (4) to inoculate pines. (5) Symptoms develop on the pine seedlings and seedling responses to infection are evaluated.

TELIA

UREDIA

RESISTANCE SCREENING CENTER

FOREST PEST MANAGEMENT STAFF
SOUTHEASTERN AREA, STATE AND PRIVATE FORESTRY
U.S.D.A. FOREST SERVICE
P.O. BOX 5895
ASHEVILLE, N.C. 28813

LEGEND

RESISTANCE SCREENING PROCESS

LIFE CYCLE OF FUSIFORM RUST

2. Inoculate oak host with spores (aeciospores collected from infected pines) to produce a different type of spore (basidiospores) which will infect pines.

3. Harvest spores (basidiospores) from infected oak leaves and prepare spore dilutions of standard density. Critical control and standardization of the inoculum spray is achieved by using an electric particle counter similar to the type used by hospitals to obtain blood cell counts. Without this modification of a medical device, the screening process would be less accurate and more difficult to conduct.

4. Inoculate 6-week-old pines using an automated mechanical spray system, and incubate at a temperature and humidity optimum for infection. The automated spray system is designed to expose each seedling tested to the same amount of inoculum (spores).

5. Evaluate pine seedlings for gall formation after a period of time sufficient for symptom development.

In the standard test, three trays of 20 seedlings from each seed lot are inoculated. The process is then repeated on a second day. At the same time, the Center's own standard check seedlots (usually one resistant and one susceptible) are inoculated for comparison with the client's seedlings. The inoculum (aeciospore) source area is selected by the client according to seed source, planting destination or other criteria. Modifications of the test design for research purposes may be desirable and can be accommodated within the constraints of the resistance screening process.

Tests for fusiform rust provide conservative estimates of the proportion of resistant seed sources. Statistical analysis of the results are included in reports to clients to aid in determining if there are meaningful differences between seed sources (figure 1). These analyses also provide a measure of the consistency of inoculation procedures, and indicate a high level of repeatability.

RESISTANCE SCREENING CENTER
SEEDLOT INFECTION MEANS

INFECTION RANK	SEEDLOT	TEST MEAN	DUNCAN'S MULTIPLE RANGE ON SEEDLOT TEST MEANS
—	Resistant Check	40	*
1	Seedlot 1	52	*
2	Seedlot 2	54	* *
3	Seedlot 3	57	* * *
3	Seedlot 4	57	* * *
3	Seedlot 5	57	* * *
6	Seedlot 6	60	* * * * *
7	Seedlot 7	61	* * *
7	Seedlot 8	61	* * *
9	Seedlot 9	63	* * *
10	Seedlot 10	64	* * *
10	Seedlot 11	64	* * *
10	Seedlot 12	64	* * *
—	Susceptible Check	64	* * *
13	Seedlot 13	65	* * *
14	Seedlot 14	67	* *
15	Seedlot 15	70	*
	All Seedlots	60	

Figure 1.—Statistical analysis of results included in reports to clients.

RELATED SCREENING SERVICES

Although the Center's services are based on scientific principles, the staff does not conduct research. However, the Center frequently cooperates with scientists who wish to conduct parts of their research with the aid of the Center's facilities. Slight modifications in the screening process can help scientists conduct tests designed to answer questions concerning such things as the nature of variation in the rust fungus and the effectiveness of fungicides.

How To Submit Seed For Resistance Screening

Anyone who would like to have loblolly or slash pine seed screened for resistance to fusiform rust should submit cleaned seed of good quality. Because 120 seedlings per seedlot are required for screening, a minimum of 400 seeds per seedlot should be submitted. This service is offered to clients for $25 per seedlot or, for a nonstandard design, $25 per six trays of 20 seedlings. Billing is made when the seedlots are scheduled for screening. Healthy (noninfected) seedlings are available to clients at the end of the tests.

Tree improvement cooperative members should send seedlots through their cooperative program:

North Carolina State University Cooperative—
Dr. Robert J. Weir
School of Forest Resources
North Carolina State University
Raleigh, N.C. 27607

University of Florida Cooperative—
Dr. Ray Goddard
School of Forest Resources and Conservation
University of Florida
Gainesville, Fla. 32611

Western Gulf Cooperative—
Dr. W. J. Lowe
WGFTIP
c/o Forest Science Laboratory
College Station, Tex. 77843

All others should send seed directly to the Resistance Screening Center.
For additional information, contact:

Resistance Screening Center
Forest Pest Management
Southeastern Area, USDA Forest Service
P. O. Box 5895
Asheville, N.C. 28813

This leaflet was prepared by Susan D. Hubbard, Resistance Screening Center Manager, Resistance Screening Center, and Robert L. Anderson, Supervisory Plant Pathologist, Asheville Field Office, Southeastern Area.